Using Galactic Cosmic Radiation to Measure Water Tank Contents in Microgravity

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Abstract & Background

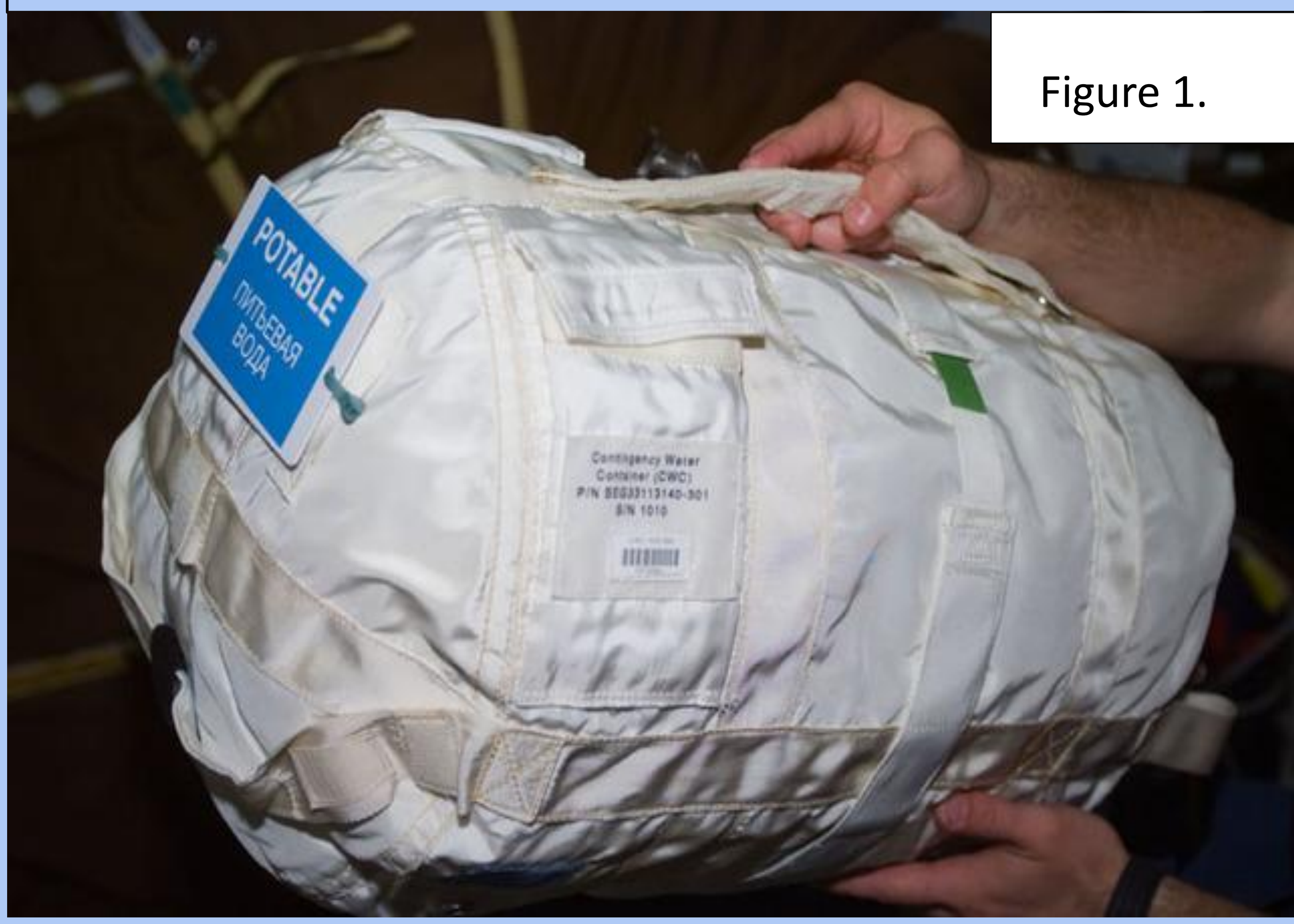
A CWC is a slightly flexible teflon tank to store water in space. Measuring CWC contents in microgravity is challenging due to erratic water shapes. A new technique using GCRs is being developed. GCRs produce secondary particles, including H+ (protons), when they hit the tank's contents. Sensing changes in proton levels will indicate changes in GCRs and water levels.

The CWC function like bladders, deflating when empty and forming a capsule when full. Without an accurate method to measure water in microgravity, NASA must overestimate water refills. This increases spending on cargo, using more of NASA's budget.

We will use the RLM technique to determine water levels in the tank by placing proton sensors outside the tank, along with a GCR sensor for GCR flux. The OLTARIS simulation model verified that proton flux correlates with water amount and is unaffected by varying water and air distributions inside the tank. Initial results support the RLM method, but further simulations were needed to confirm its effectiveness.

Currently, the CWC was only tested when fully inflated, but it can also deflate due to its flexibility. Therefore, multiple states of the CWC were needed to be tested to realistically simulate its geometry.

Figure 1.



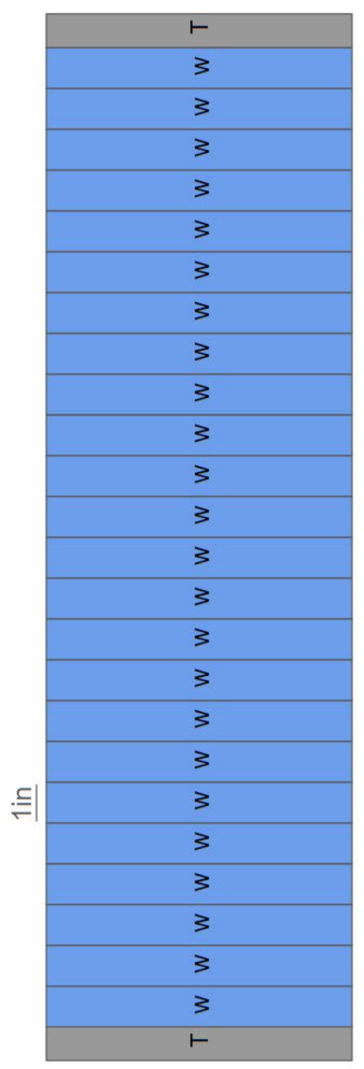
Methods

Using the OLTARIS model, simulations were run on slabs (Figure 2). Two separate tests were run.

1. To test the deflation of the CWC, 1 inch layers were taken out until the tank was empty. This resulted in 24 tests, as the CWC was assumed to be 24 inches in length, and 6 inches in radius. The results are shown in Figure 2.

2. In order to determine whether the location of the proton sensor relative to the CWC affects the proton flux readings, 2 separate tests were run. Air was added in 20 inch increments (20in - 80 in.) in front of the CWC. Both dry air and normal humidity air were tested. The results are shown in Figure 4 & 5.

Figure 3.

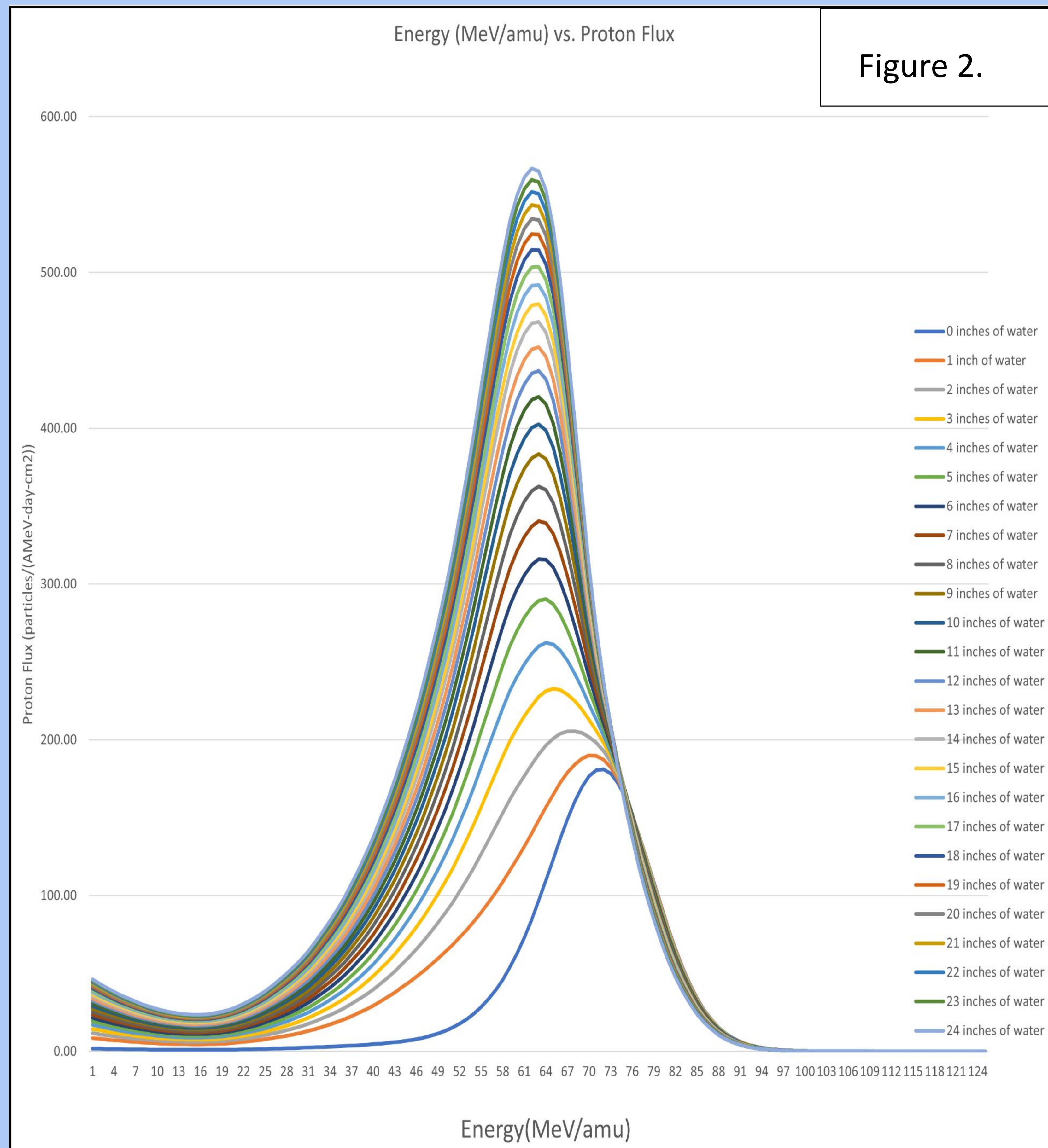


Conclusions

After running the two experiments, the following results were concluded.

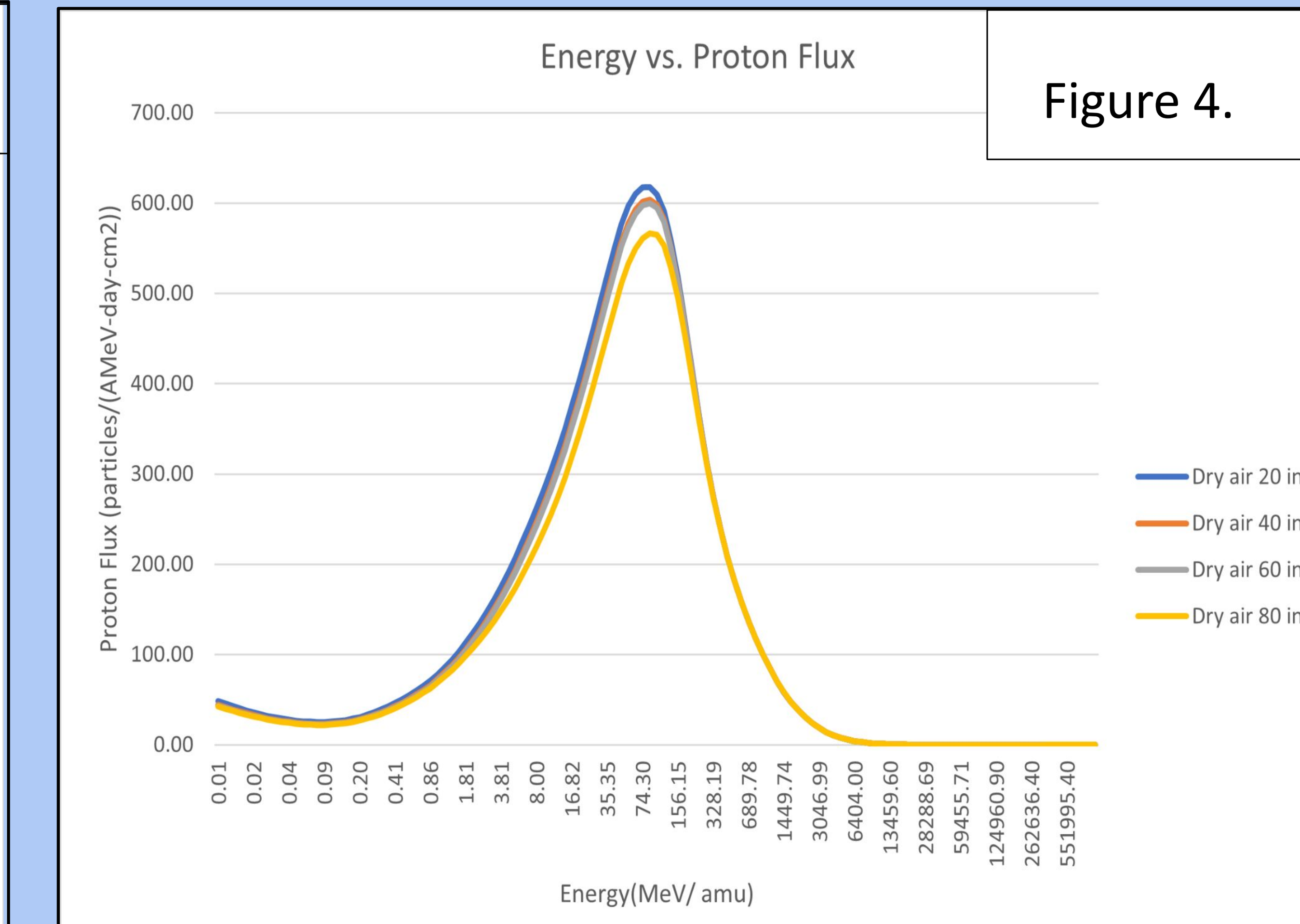
1. The deflation and inflation of the bag in both the x and y axis still produce the appropriate proton flux. This means that the proton sensor will be able to gather accurate readings.
2. The distance from the CWC does not have a significant effect on proton readings. This means that the location of the proton sensor does not significantly change the effectiveness.

Figure 2.



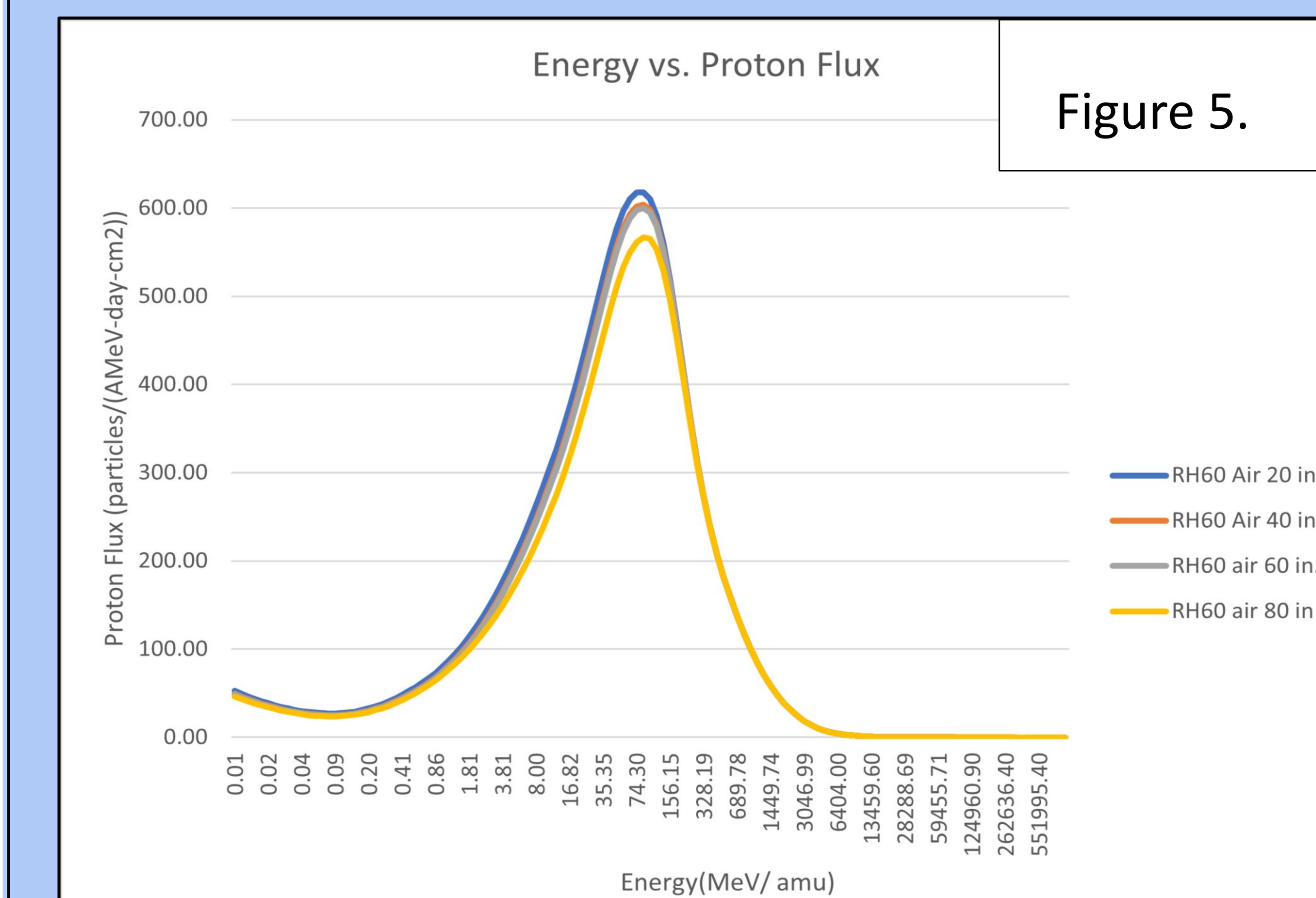
Reducing water layers in 1 inch increments to observe the changes in proton flux.

Figure 4.



Increasing the intervals of dry air by 20 inches to observe the changes in proton flux

Figure 5.



Increasing the intervals of RH60 air by 20 inches to observe the changes in proton flux.

Nomenclature

CWC - Contingency Water Container

RLM - Radiometric Level Measurement

GCR - Galactic Cosmic Radiation

OLTARIS - On-Line Tool for Assessment of Radiation in Space

References